Adapting and Testing the COAMPS/COBEL Low Cloud Nowcasting System for Winter Conditions

Professor Peter Zwack,
Earth and Atmospheric Sciences Department
Université du Québec à Montréal
P.O. Box 8888, Station 'Downtown' Montreal, Quebec H3C 3P8, Canada
phone: 1-514-987-3000 ext. 3304 fax: 1-514-987-7749 email: zwack.peter@uqam.ca

Award Number: N00014-01-1-0377
http://people.sca.uqam.ca/~cobel/COTE_EST/
http://people.sca.uqam.ca/~tardif/COBEL/cobel_enter.htm

LONG-TERM GOALS

An improved an automated, globally applicable, integrated ceiling forecast product in DAMPS that will give the on-scene meteorologist a new capability to provide useful environmental information tailored to the individual needs of Navy aircraft pilots.

OBJECTIVES

The NRL COAMPS (Coupled Ocean/Atmosphere Mesoscale Prediction System) regional ceiling product will be blended with the UQAM COBEL (Code Brouillard Eau Liquide) column modeling technology to produce more precise forecasts of ceiling height and the time of clearing of stratocumulus ceilings than are provided by either model separately. The value of this product to regional forecasters, the global applicability and skill of this technology will also be assessed.

APPROACH

The methodology will make use the strengths of both NRL's COAMPS and UQAM's COBEL model. The latter has the capability of performing very high resolution calculations of boundary layer processes in a column in the atmospheric boundary layer while COAMPS can provide detailed information of the characteristics of the air flowing into and above the column. Preliminary work using data in the region of Point Mugu has shown that that combining COBEL with advections calculated from the output from COAMPS (Christian Pagé at UQAM and John Cook at NRL) can make improvement in skill of the ceiling forecast of summer marine stratocumulus, compared to forecasts from COBEL or COAMPS alone. COBEL's capabilities were extended in 2001 to the cold season by adding (Wanda Szyrmer and Eva Monteiro at UQAM) winter cloud and precipitation parameterizations of ice, snow and supercooled water (Fletcher 1962, Reisner et al 1998, Hallettand and Mossop 1974, Kessler 1959, Lin et al 1983, Meyers et al 1992, Pruppacher, and Klett, 1978, Rutledge and Hobbs 1984).

WORK COMPLETED

A series of similar suitable cases have been identified for testing the hybrid COAMPS/COBEL cold season stratocumulus forecast using the combined COAMPS/COBEL forecast system. After a review

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 2003		**00-00-2003 to 00-00-2003**

4. TITLE AND SUBTITLE
Adapting and Testing the COAMPS/COBEL Low Cloud Nowcasting System for Winter Conditions

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Earth and Atmospheric Sciences Department,,Universite du Quebec a Montreal,P.O. Box 8888, ,Station Downtown,Montreal, Quebec H3C 3P8, Canada, ,

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)
11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
An improved an automated, globally applicable, integrated ceiling forecast product in DAMPS that will give the on-scene meteorologist a new capability to provide useful environmental information tailored to the individual needs of Navy aircraft pilots.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT	b ABSTRACT	c THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**6**	

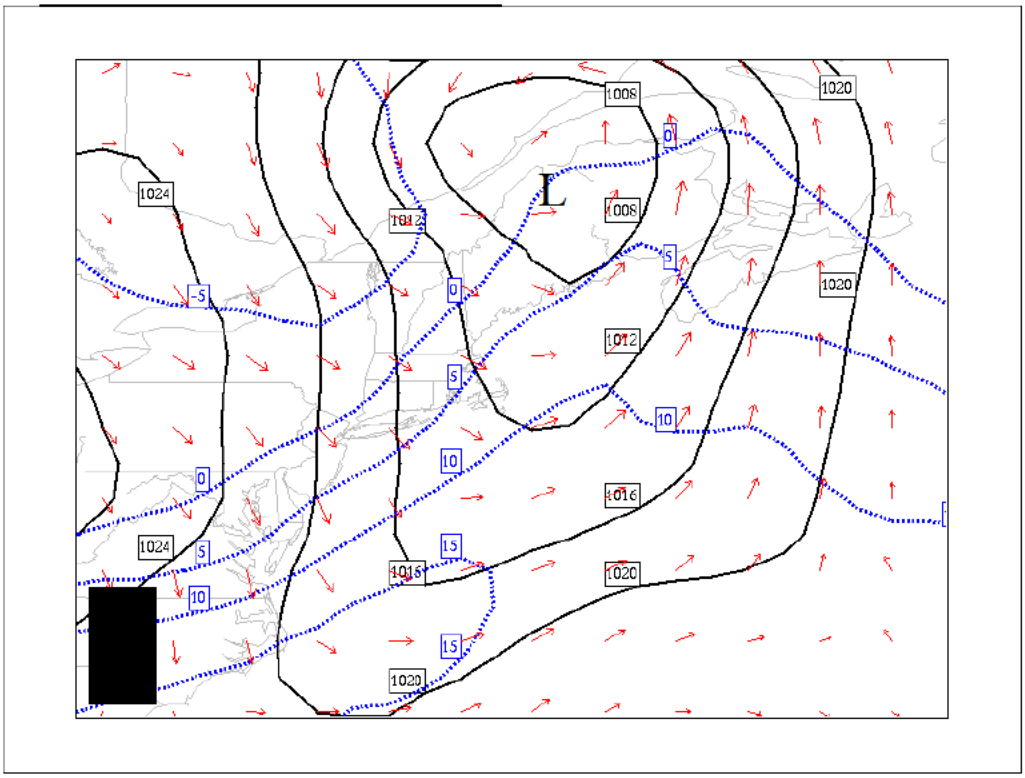

Figure 1. 12 GMT, November 9, 2001: Sea level pressure (black lines every 4 hPa), 925 hPa wind vectors (red arrows) and 925 hPa isotherms (blue dashed every 5 C)

of several recent cold seasons by Nathalie Gauthier at UQAM, the stratocumulus in the Albany, New York area on November 9, 2001 in was chosen as the first test case for which for which it would be possible to run COAMPS. The synoptic weather map at 12 GMT (Figure 1) shows a region of cold air advection over New England following a low pressure system, which had just left the region and was heading for the Canadian Maritime Provinces. The satellite photo (Figure 2) and the morning sounding (Figure 3) suggest that this was a typical case of cold air outbreak stratocumulus that is capped by a subsidence inversion.

After a series of attempts at running protoype COBEL/COAMPS systems using various versions of COAMPS output, an acceptable configuration was finally arrived at during the late summer of 2003. This version of COAMPS output provided an initial profile of temperature and humidity above and in the ground in the Albany area as well as one hour average horizontal advections of temperature and humidity above Albany calculated within and during the COAMPS integration. A 12 hours forecast was then run using the COAMPS vertical profile of temperature and humidity to initialize the COBEL column and COAMPS horizontal temperature and humidity advections to provide horizontal input into the COBEL column.

The resulting liquid cloud forecast for the 12 hours beginning 12Z are shown in Figure 4 in comparison with the observed cloud base and cloud amount from the Albany METAR. These results, when compared to any other forecast system for stratocumulus, are quite good.

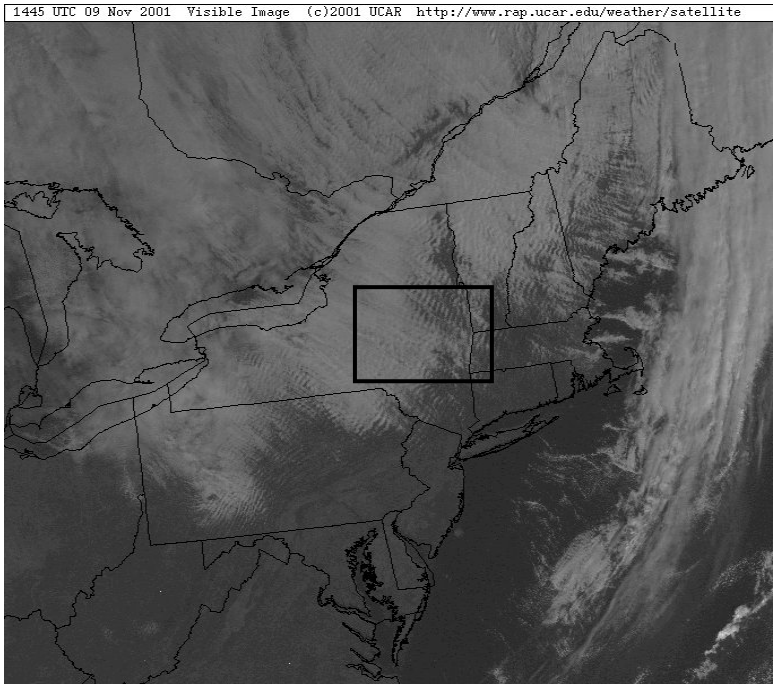

Figure 2. Visible satellite image in the Northeastern U.S. at 1445 GMT on November 9, 2001 showing stratocumulus clouds over much of Northern New England. A box outlines the stratocumulus clouds in the Albany, New York region.

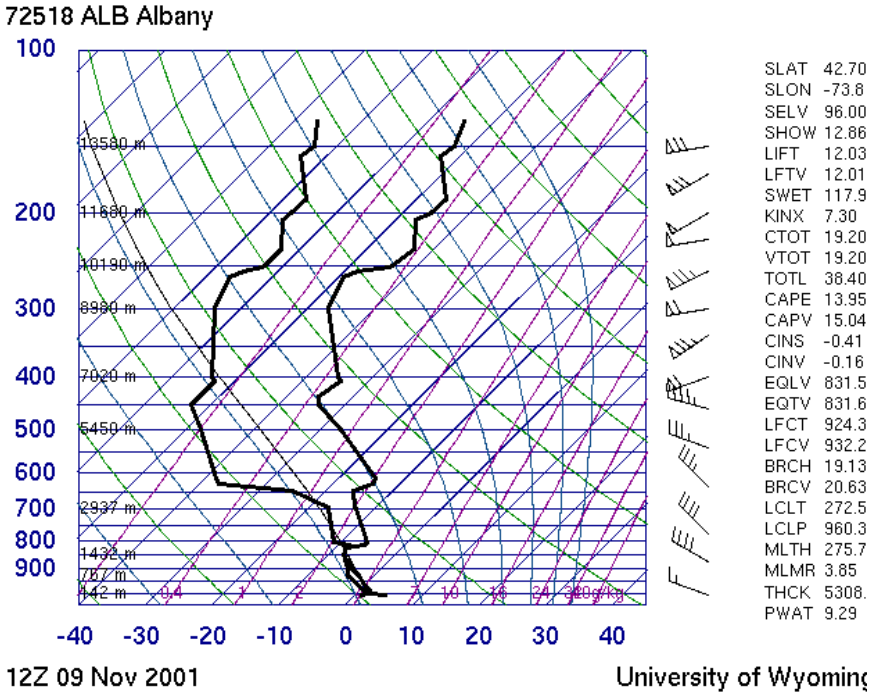

Figure 3. Sounding of temperature and dewpoint at 1200 GMT November 9, 2001 at Albany, New York plotted on a Skew-T diagram. The profiles from the surface to 700 mb show typical features of cold air outbreak stratocumulus: moist and dry adiabatic lapse rates downward from the base of a subsidence inversion at 800 mb.

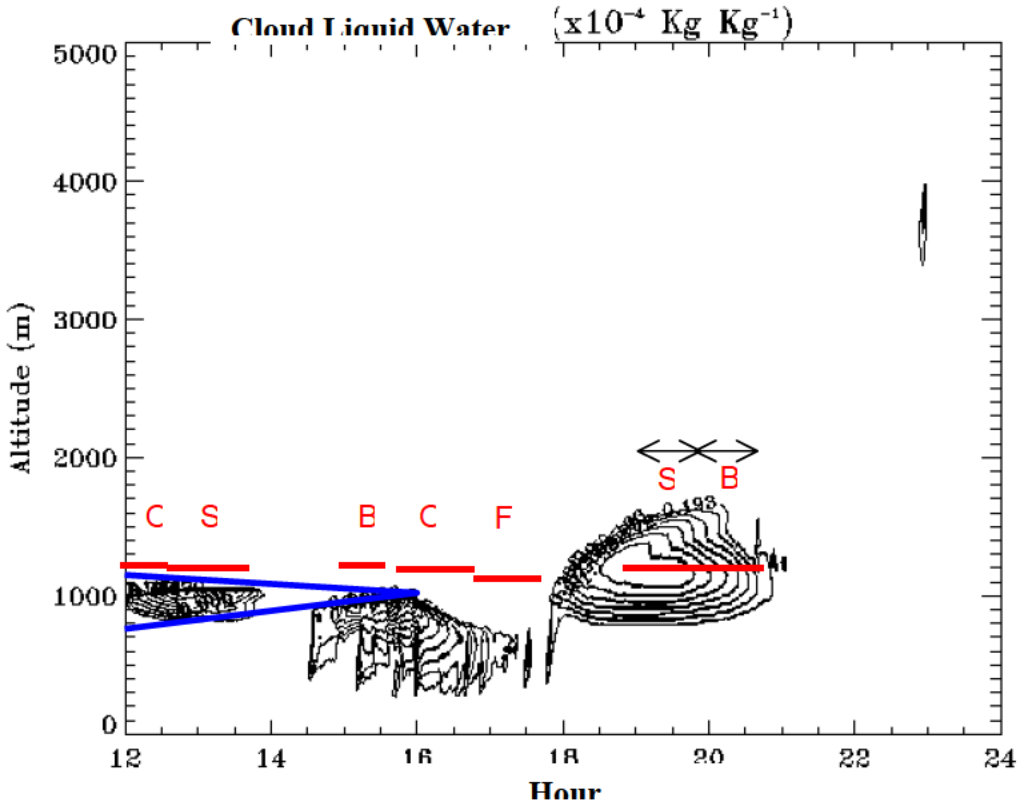

Figure 4 Cloud liquid water mixing ration forecast by COBEL/COAMPS system as a function of height above Albany (black lines in 0.2 x10-4 Kg/Kg). The METAR cloud base observations are in red horizontal lines with the letters indicating cloud amount (0-overcast, B-broken, S-scattered, F-few). The blue line represents the cloud region forecast by COAMPS alone.

The COAMPS/COBEL system nearly reproduces the times of occurrence of onset and dissipation of periods of ceiling (overcast and broken) and non-ceiling with an accuracy of about an hour for forecasts out to 10 hours. For two of the periods with ceiling conditions, the cloud base is forecast correctly (when compared to the METAR) within a few hundred meters. Only in the middle period (14-17 GMT) was the cloud base significantly too low by several hundreds of meters. These results are significant improvements over the COBEL forecast alone which produced continuous overcast stratocumulus cloud over the entire 12 hour period with a similar cloud base error as well as over the COAMPS forecast that did not forecast a ceiling beyond the first 4 hours.

IMPACT/APPLICATIONS

The hybrid COAMPS/COBEL forecasting system has shown to have the potential of being an important tool for improving the forecasts of boundary layer processes that have significant impact on Navy aviation operations such as the formation and dissipation of cold air outbreak stratocumulus cloud. However, it will be necessary to validate the results reported on here in a series of similar test cases.

TRANSITIONS

The COBEL Model is part of the FAA SFO Marine Stratus Nowcast System for forecasting summer marine stratus burnoff in the Bay area, which is being implemented by the National Weather during this year. The FAA is also funding a multi-year development of a COBEL/RUC hybrid system for forecasting low ceilings and visibility over the US.

RELATED PROJECTS

The development of a hybrid RUC/COBEL forecast system is being planned at part of the FAA National Ceiling and Visibility Initiative that is just getting underway this fiscal (2001) year.

REFERENCES

Ek, M., and L. Mahrt, 1991, OSU 1-D PBL Model User's Guide, version 1.0.4., Department of Atmospheric Sciences, Strand Agriculture Hall, Oregon State University, Corvallis, Oregon, USA.

Fletcher, N. H., 1962: The Physics of Rain Clouds, Cambridge University Press, 386 pp.
Reisner, J.J, R.M. Rasmussen, R.T. Bruintes, 1998: Explicit forecasting of supercooled water in winter storms using MM5 mesoscale model, QJR Meteorol. Soc., **124**, 1071-1107.

http://www.mmm.uqar.edu/mm5/mm5-home.html

Hallett, J., and S. C. Mossop, 1974: Production of Secondary Ice Particles During the Riming Process. Nature, **249**, 26 –28.

Kessler, E., 1959: On the distribution and continuity of water substance in atmospheric circulations. Met. Monograph, **10**, No. 32, American Meteorological Society, Boston, 84 pp.

Lin, Y.-L., R. D. Farley and H. D. Orville, 1983: Bulk parameterization of the snow field in a cloud model. J. Climate Appl. Meteor., **22**, 1065 – 1092.

Meyers, M.P., P.J. DeMott and W. Cotton, 1992: New Primary Ice Nucleation Parameterization in an Explicit Cloud Model, J. Appl. Meteor., **31**, 708 – 721.

Pruppacher, H. R., and J. D. Klett, 1978 : Microphysics of Clouds and Precipitation, Reidel, 714 pp.

Rutledge, S. A. and Peter V. Hobbs, 1984 : The Mesoscale Microscale Structure and Organization of Clouds and Precipitation in Midlatitude Cyclones. XII : A Diagnostic Study of Precipitation Development in Narrow Cold-Frontal Rainbands , J. Atmos. Sci., **41**, 2949 – 2972.

HONORS/AWARDS/PRIZES

Université du Québec à Montréal received in 2002 the U.S. Federal Aviation Agency (FAA) Excellence in Aviation Award as did all the participants in the FAA Weather Research Program.